THE TELEGRAPHIC JOURNAL.

Vol. II.—No. 34.

ELECTRO-DEPOSITION OF METALS.

By J. T. SPRAGUE.

In order to apply the principles already explained in the most ready manner, I have drawn up a table of the substances most generally employed in batteries and in electro-deposition, showing the amount of each required to act with the unit of electric quantity and current (which amount will hereafter be spoken of as the unit), and also the cost of this unit for each substance. The weight (column V.) allows for the ordinary impurities always present in commercial articles, and applies to good commercial materials not intentionally adulterated. The price (column VII.) is such as the substances can be obtained at in the ordinary way (with the exception of the silver salts), and where a different price is paid the user can readily apply a correction to the unit cost (column VIII.) in all following calculations.

Under the French system such a table would be far more useful than our wretched confusion of weights and measures allows it to be, as the figures obtained for the small units would apply equally to the largest amounts used in practice, while in the English system one calculation is needed to convert grains into pounds, and then another to ascertain the cost of these larger quantities.

The selection of the most suitable battery for any given purpose involves several considerations—electromotive force, internal resistance, constancy, and cost. For electro-metallurgy, in almost all

SUBSTANCES USED IN ELECTRO-DEPOSITION.

No.	I Name.	II Atom in Weight.	III Symbol.	IV Valency.	V Commercial Equivalent.	VI Equivalents per lb.	VII Price per lb.		VIII Cost per Unit.
					Grains.		s.	d.	d.
1	Acid hydrochloric	36·5	H.Cl	1	113	61	0	2	·0326
	„ „ liquid..	—	Sp. gr. 1160		85				
2	„ nitric..	63	HNO_3	1	96	73	0	8	·1096
	„ „ liquid	—	Sp. gr. 1400		69				
3	„ sulphuric	98	H_2SO_4	2	50	140	0	1½	·0107
	„ „ liquid ..	—	Sp. gr. 1846		28				
4	Ammonia	17	NH_3	1	48	148	0	9	·0608
	„ liquid	—	Sp. gr. 880		55				
5	Ammonium chloride ..	53·5	NH_4Cl	1	56	125	0	6	·048$_0$
6	„ sulphate ..	132	$2(NH_4)SO_4$	2	70	100	0	3	·030$_0$
7	Calcium chromate	349	$CaCrO_4+1Aq$	2	60	116	0	7	·060^0
8	Copper	63·5	Cu	2	33	212	1	0	·056^4
9	„ sulphate	249·5	$CuSO_45Aq$	2	126	55	0	5	·090^6
10	Iron	56	—	2	30	232	0	2	·008^0
11	„ sulphate	278	$FeSO_47Aq$	2	145	48	0	2	·041^6
12	Lead sulphate	303	$PbSO_4$	2	159	44	0	6	·136^4
13	Manganese, peroxide ..	87	MnO_2	—	100	70	0	4	·057^3
14	Mercury	200	Hg	2	100	70	4	0	·685^2
15	Mercuric sulphate	296	$HgSO_4$	2	150	46	4	0	1·028^7
16	Potassium cyanide (white)	65	KCN	1	100	70	3	0	·514^5
17	„ bichromate ..	295	K_2O2CrO_3	2	50	140	0	10	·071^4
18	Silver	108	Ag	1	108	64	135	6	16·406^5
19	„ chloride	143·5	AgCl	1	144	48	80	0	20·000^2
20	„ cyanide	134	AgCN	1	134	52	80	0	18·500^0
21	„ nitrate	170	$AgNO_3$	1	172	40	60	0	17·691^0
22	Sodium, chloride	585	NaCl	1	60	116	0	0½	·004^4
23	„ nitrate..	85	$NaNO_3$	1	87	80	0	2	·024^3
24	Zinc	65	Zn	2	34	201	0	4	·019^9
25	„ amalgamated	—	—	—	—	—	0	6	·029^5
26	„ sulphate	287	$ZnSO_47Aq$	2	148	47	0	3	·063^2
27	„ and H_2B_4 cell	—	1 to 10 water fluid	—	365	—	—		·043$^4_8$

1. Hydrochloric Acid.—Variable in strength; good quality is of sp. gr. 1·16, and contains about 32 per cent HCl.

2. Nitric Acid.—This varies greatly through the various qualities sold as nitric acid, aquafortis—double and single, dipping acid, &c. The highest strength has a sp. gr. 1·5; ordinary good commercial is about 1390 to 1420, and contains from 65 to 75 per cent HNO_3. I have taken the acid at 1400, and as equal to 70 per cent.

3. Sulphuric Acid.—This means concentrated oil of vitriol, sp. gr. 1845, which is obtainable nearly pure.

4. Ammonia, sp. gr. 880, contains 36 per cent NH_3.

16. Potassium Cyanide.—Varies in quality from about 50 per cent to 75, the highest which can be made, as the process involves the production of a proportion of cyanate. The quality is taken as 65 per cent.

18 to 20. The Silver Salts are calculated as if made, allowing for labour, the silver being taken at 6s. per ounce troy. The cyanide is supposed to be simply precipitated and washed, not dried, and reckoned at 5s. per ounce. The chloride has an extra charge on it to pay for separation and fusion for use in batteries, and is therefore at the same price as the cyanide. The chloride ought to be obtainable 3d. per unit cheaper, in fact at its worth in silver,—that is, at 68s. per lb.,—as it is a product in silver working, and has to be reduced for the sake of its metal. Nitrate of silver may be bought at 3s. 9d. per ounce, the price in the table. The cyanide should never be purchased, as it ought not to be dried.

cases a large current is the first consideration, and this cuts off a very considerable number of the long list of forms; those left available are the common single acid cells, the Wollaston and Smee, the Daniell, and the nitric acid cells. As every unit of action involves the consumption in each cell of one unit of every substance acted upon chemically, the foregoing table enables us to calculate at once the cost per cell for each unit; but this alone will not give us the actual cost. To obtain this in a form which permits comparison, we must include the consideration of the force produced and required to overcome the resistance; for supposing one nitric acid cell is required to do the work at a certain rate, it would require three Smees to effect the same. The true mode of estimating the relative cost of different forms of cell is to reckon it, not per unit of current, but per equivolt of energy, which unites the two elements. This is obtained simply by dividing the cost per unit by the electromotive force, and shows the relative cost for equal work done; but this does not take into consideration the element of internal resistance, which is largely dependent upon the relative size of the cells. Another consideration which cannot be reckoned is the relative convenience of management, such as is afforded by the single liquid cells by dispensing with porous vessels. The following table shows the relative costs thus calculated:—

Cell.	Cost per unit Penny.	E. M. Force volts.	Cost per equivolt.
Copper zinc ...	0·0438 ...	0·280 ...	0·1564
Smee	0·0438 ...	0·500 ...	0·0876
„ odds & ends	0·0284 ...	0·500 ...	0·0568
*Daniell	0·0584 ...	1·079 ...	0·0541
Nitric acid ...	0·1570 ...	1·600 ...	0·0981

Here it is seen at once that the cheapest form of battery, the old copper and zinc plates in sulphuric acid, is the dearest of all to work with, because of its low force.

The Smee is the cell most commonly employed because of its extreme simplicity of construction and management. Its familiar form is that of a platinised silver plate in a frame, with a zinc plate clamped upon each side of it; but on a large scale it is better to reverse the arrangement, to suspend a silver plate on each side of the cell and the zinc plate in the middle, thus reducing the waste by local action. Each zinc in such case, for regular working, should always be in the form of at least two plates, each separately clamped to a connecting bar crossing the cell; one of them can then be removed and replaced by a fresh plate without much deranging the work going on.

A very good mode of connecting the zincs, however, is to have a narrow trough containing mercury across the bottom of the cell, connected by means of a wire covered with cement, so that merely standing the plate in the trough connects the zinc at once, and also keeps up its amalgamation.

The zincs should be of the best rolled plate, about a quarter inch thick, and well amalgamated by dipping in sulphuric acid and water, and rubbing over with mercury till bright, the excess of mercury being then allowed to drain off. For good working the plates should be well brushed, and the amalgamation renewed every twenty-four hours. It is bad economy to spare mercury, and the mercury can nearly all be recovered. The proper mode is to remove the zincs and brush off the powdery deposit in a pan of water, and then rub them over in another pan with a little mercury in the bottom of it. The deposit in the first should be collected and placed in a vessel containing sulphuric acid and water to dissolve out zinc. The mercury may after a time be distilled off the residue, or it may be placed in a vessel with dilute nitric acid for some time. This will dissolve off the foreign metals, leaving mercury and sulphate of lead, and the latter can be washed off by stirring in water and pouring off, when the mercury will remain nearly pure. A cheap working form of the Smee cell is what he called the odds and ends cell, though it has inconveniences which have prevented its being much used. It consists of a cell containing a stratum of mercury at the bottom with a connecting wire. Into this are plunged any scraps or cuttings of amalgamated zinc, and a plate of platinised silver is suspended above. The most convenient form, however, is a porous cell with a sheathed wire fixed to it, and going to the bottom into a stratum of mercury. The scraps of zinc such as broken residues of plates, or ordinary zinc cuttings in suitable sizes, are stirred in acid and water with a little mercury, and then put in the cell; at intervals the whole can be emptied in a pan of water, cleaned off and replaced, the mercury being squeezed through a wet chamois leather to remove lead, and the residue treated as before described.

The Smee cell is not constant. Its electromotive force when tested against a high resistance is about 1·1 volt, but in full work becomes less than half this. Its internal resistance is also variable with the rate of working, because the hydrogen given off covers a large surface with bubbles as its rate of evolution increases. But when a definite rate of work is once attained the cell is very fairly constant, diminishing its current slowly as the acid becomes saturated with zinc, and so increases in resistance. The great point for good working is to have plates amply large enough for the work, and the containing vessels large enough to hold a good supply of liquid. This applies to all forms of battery which are usually made up in vessels too small for good working.

The strength of acid should not exceed 1 of oil of vitriol, sp. gr. 1·845, to 10 of water, both by measure; a pint of such solution is equal to doing 25 units of work, still leaving about one-fifth of the acid unused. This should always be done, as if the acid becomes saturated with zinc in one cell of a series the zinc is deposited upon the silver and is very difficult to remove. The same will occur even with a single cell at times when the action is slow, owing to a dense stratum of saturated solution forming at the bottom. The mixed acid and water should be allowed to cool before use, and any cloudiness, due to lead sulphate, allowed to settle, or still better, be filtered off, as if left the lead will be reduced upon the silver plate. There is less local action, however, when a weaker solution of acid is used. Economy of acid may be effected by drawing off the lower part of the liquid, which for this purpose should extend a good way below the silver plates. The solution so removed may be

---

* The cost of the Daniell is nearly double this if the value of the deposited copper is not considered.

placed in a tall vessel, and treated in the same way after a time to settle, as the sulphate of zinc is so very heavy that a dense lower stratum will form, or if convenient the removed solution may be placed in shallow vessels, and allowed to evaporate, when the greater part of the zinc sulphate will crystallise out. This is rarely done, but it might be done economically where a shallow lead vessel could be placed over a flue or any waste heat allowed to act upon it, and in some parts the crystallised salt would be saleable and pay for its production.

REPORT OF M. DELARGE ON THE SYSTEM OF PNEUMATIC TUBES EMPLOYED IN ENGLAND.

(Continued from p. 181.)

MM. **Siemens Brothers** have made a number of experiments with the view of finding a formula for estimating, in various cases, the velocity of the air in the tubes.

Their apparatus were arranged as follows:—A tube, whose diameter and length could be varied at will, was connected with a reservoir into which air was forced, or in which a vacuum was made by means of a hand-pump. At the other end of the tube was an indicator, showing exactly the volume of air passing at atmospheric pressure. Dividing this volume by the section of the tube gave the velocity of the air in the indicator. The same weight of air traversing the different sections of the tube in a given time, it is possible, by a manometer (according to the law that the volumes are in inverse ratio of the pressures), to deduce the velocity with which the air enters the reservoir, also the velocity at different points of the tube.

MM. Siemens's formulæ (approximate only, since the velocity increases rather faster than the square root of the diameter of the tubes) are as follows:—

Final velocity—

$$v_2 = a \times \frac{h-h_1}{h} \sqrt{\frac{d}{l}} \dots\dots\dots (1).$$

Initial velocity—

$$v_1 = v_2 - \frac{h_1}{h} = a h^1 \times \frac{h-h_1}{h^2} \sqrt{\frac{d}{l}} \dots (2).$$

Average velocity—

$$v^1 = \frac{v^1+v^2}{2} = a \times \frac{h^2-h_1^2}{2h^2} \sqrt{\frac{d}{l}} \dots (3).$$

Velocity at distance x (starting from commencement of tube)—

$$v = a \times \frac{(l-x)\,h_1 + x h^2}{l} \times \frac{h-h_1}{h^2} \sqrt{\frac{d}{l}}$$

l, length of tube; d, internal diameter; h, pressure (in atmospheres) of the air at its entrance into the tube; h_1, pressure of air at its issue; a, a certain constant, dependent on the nature of the interior walls of the tubes,—for leaden tubes it equals 15·95, and for forged iron it is 14·192. The velocities, $\imath$, v^1, v_1, v_2, were obtained in English feet.

Let the tube have a length of 3·965 m. and a diameter of 0·076; let the effective difference of the pressure $h-h_1$ be one atmosphere, then we have the following mean velocities:—

	Metres.
(1). v' with a pressure of one atmosphere	7·99
(2). v' with a vacuum of one atmosphere	10·68
(3). v' with a pressure of half an atmosphere, and a vacuum of half an atmosphere ...	9·49

These results show that, in a tube of determinate length and section, the velocity is notably altered if the pressures are modified at the two extremities, though their difference remains constant. These formulæ apply to the passage of cases in the tubes, for the friction of these is so slight that it may be neglected in comparison with the air friction.

It is to be remarked that MM. Siemens's formula differs from those given by several authors, the velocity being in it proportional to the first power of the pressure. Moreover, according to Coulomb, the coefficient of friction is independent of the nature of the tubes. According to experiments which M. Poncelet made with the apparatus of M. Pecquem, the velocity of flow of gases in long tubes is given by the formula—

$$V^2 = \frac{2g(P-p)}{0{\cdot}024k.\frac{L}{D}}$$

where $g=9{\cdot}808$; k is the weight of a cubic metre of the gas, L the length of the tube, D the diameter P and p pressures of the gas at the two extremities This has been established on the hypothesis that gases behave like liquids.

The figures representing the forces of the machines in England are very variable. We will try to give an approximate estimate of the minimum force required in the action of a determinate length of tube. Take the case of a lead tube 1000 m. length and 0·057 m. diameter, wrought on Mr. Clark's system, and a constant pressure of 0·702 k. per square centim. on the circulating core maintained. This work is represented by—

$$T = S.P.V.$$

S being the section of the tube, P the pressure per unit of surface, and V the velocity per second.

The values S and P are known. V, as per Siemens's formula (3) =

$$15{\cdot}950\,\frac{h^2-h_1^2}{2h^2}\sqrt{\frac{d}{l}} = 11{\cdot}80 \text{ m.},$$

whence we obtain T=211·22 kilogrammetres=2·81 horse power. Adopting 0·63 for coefficient of useful effect, the nominal force of the machine becomes 4·46 horse power. The length of the tube *per horse power of force* will, therefore, be 224 metres.

If the case, however, is sucked along by a vacuum, the tension of air in the reservoirs must be only 0·331 k for the excess of atmospheric pressure on the case to be 0·702 k; then $v=16{\cdot}19$ m. The corresponding work is 289 kilogrammetres, which is the product of 3·86 horse power. Consequently, the nominal force of the machine must be $\frac{3{\cdot}86}{0{\cdot}63} = 6{\cdot}12$ horse power, and the length of the tube *per horse power of force* will be 163 m. This length may be considered as the maximum that can be adopted with the tubes of Clark's system. We think that, in practice, taking into account the resistances that may occur from sinuosities in the tube, the length should not exceed 150 m. per horse power, which is nearly what we find in London.

The duration of MM. Siemens's tubes is found to be less than those of M. Clark's system, and the service is less complicated when each office is connected directly with the central one by a tube meant for its exclusive use. Besides, a current of air circulating continually in the Siemens tubes, there is loss of motor force if the business is not sufficiently great for the tubes always to be traversed by a case. On the other hand, the work obtainable from the Siemens tubes may be greater than that from Clark's, because it is possible to send a case before the preceding one has arrived at the next office. The economic advantages presented in the application of one or the other system thus entirely depend on local conditions.

ON THE ELECTROMOTIVE FORCE OF LIQUID BATTERIES.

THIS subject is studied by M. Paalzow in a recent number of *Poggendorff's Annalen.* Kohlrausch alone appears to have previously endeavoured to determine the electromotive forces of liquids by the electrometric method (*Pog. Ann.*, Bd. 79, p. 200). M. Paalzow repeated his experiments, but without success. The quantity sought is not only masked, but often exceeded by electricities, which the insulators of the measuring apparatus accumulate, and which, in the manipulations that are necessary, always recur.

With aid of the galvanometer, on the other hand, some good results have been obtained. Wild has shown that there are liquids which follow Volta's law of tension; Du Bois Reymond, that by insertion of distilled water into the series of members of liquid batteries, the highest value of electromotive force of liquids is attained. Worm-Muller considers that water is electromotively indifferent towards all liquids, from the fact that Kohlrausch has found no difference of tension between water and nitric acid, and that the thermal currents between water and other liquids are extremely weak. Two other facts appear to contradict this hypothesis: Faraday found that distilled water, in friction with other substances, gave the highest tension; and Quincke, that diaphragm-currents are considerable only with distilled water.

M. Paalzow's observations refer chiefly to the influence of the nature of the separating surface on electromotive force, the constancy of this force, and the compensation for current work.

Previous experimenters have thought it indispensable to have a sharp surface of separation between the liquids. M. Paalzow at first fulfilled this condition. He specially studied a liquid battery consisting of amalgamated zinc in sulphate of zinc, hydrated sulphuric acid, distilled water, sulphate of zinc with amalgamated zinc. The liquids were in a series of large U-tubes, the first containing sulphate of zinc, the second sulphate of zinc and sulphuric acid, the third sulphuric acid and distilled water, the fourth water and sulphate of zinc, the fifth sulphate of zinc and the electrode of amalgamated zinc. The zinc electrodes were connected with a Wiedemann mirror-compass and the electromotive force was measured by the method of compensation.

The sharp separating surface was obtained (between sulphate of zinc and sulphuric acid, *e.g.*) thus:—The sulphate was first poured into the U-tube, then the other liquid poured through a funnel with its very fine orifice at the surface of the sulphate of zinc, and a good deal of blotting-paper in the wider part. Adjoining tubes were bridged over by a syphon tube, the ends of which were bent upwards in the liquid.

Having compensated such a battery, M. Paalzow disturbed the several separating surfaces with a glass rod, and he found that the electromotive force continued the same, the needle of the compass remaining at zero. Thus, in liquid batteries, a sharp surface of separation is not of consequence, if care be taken that one liquid do not penetrate through the second to the third. This was prevented in the present case, the liquids in the syphon tubes remaining unaltered.

While the result was surprising, it might, as the author remarks, have been expected; for only in solids is a sharp surface of separation possible.

The battery described continues a pretty long time constant, owing to the great resistance and the consequently small current-work. After some time the electromotive force decreases, owing to chemical processes. The positive current has, in the battery, the direction from sulphate of zinc to acid, to water, and to sulphate of zinc. Thus, through electro-chemical processes, there is at the zinc pole of vessel 1 a dissolving of the zinc; at the surface of separation between sulphate of zinc and sulphuric acid, formation of sulphuric acid; at that between sulphuric acid and water, formation of water; at that between water and sulphate of zinc, formation of sulphuric acid; and at the last zinc pole separation of zinc. Thus, after some time, sulphuric acid is inserted between the water and the sulphate of zinc, and owing to the symmetrical arrangement now approaching in the liquids constituting the battery, the electromotive force must gradually be reduced to zero. Considering, in the case of liquid batteries, the chemical process in the battery itself, it readily appears that only those batteries can furnish a constant electromotive force, in which all the constituent liquids contain either the same acid or the same radical.

According to the principle of conservation of force, we expect a compensation in the battery itself for the current afforded. In the battery under consideration, sulphate of zinc, hydrated sulphuric acid, water, sulphate of zinc, one would seek this compensation in the caloric processes between the constituent liquids. From these the chemical processes, in reference to their calorific values, are, as previously shown, eliminated; there remain for compensation, only the processes of diffusion. To ascribe it to these, M. Paalzow thinks impossible, for he has found a battery in which, through processes of diffusion, only cold is produced, and which yet furnishes a strong current. This is the combination: Sulphate of zinc, muriatic acid, acetate of protoxide of zinc, sulphate of zinc, between zinc electrodes. Of the diffusion process here, muriatic acid mixed with sulphate of zinc gives a *lowering* of temperature; also muriatic acid with acetate of protoxide of zinc; acetate and sulphate of protoxide of zinc mixed, give no change of temperature.

"I distinguish, however, in the hydro-batteries generally, *those* chemical and diffusion processes, which also occur with the open circuit, from those which are called into play through closure of the circuit. It is only to the calorific values of the latter that the compensation for current work can be attributed. This may be explained with a Daniell element. If in constructing such we use amalgamated zinc, which, *before* closing of the circuit is hardly attacked at all, then, *after* closing, the entire calorific value of the chemical process in the battery is equivalent to the current-work. If, however, unamalgamated zinc be taken, there are two chemical phenomena to be distinguished—the dissolving of the zinc which would occur even in the open circuit, and that which is produced by the current. I have convinced myself by experiment that the purely chemical dissolving of the zinc in the closed circuit is equal to that which would occur in the open circuit, and that the current-work corresponds only to the quantity of zinc which is dissolved by the current.

A Daniell element was constructed, the zinc was not amalgamated, the circuit was open. The sulphuric acid had a sp. gr. 1·043. The zinc plate weighed before the experiment, 21·859 gr. After remaining twenty minutes in the open circuit, it weighed 21·114 gr., having thus lost 0·745 gr.

A second Daniell element was made as like the first as possible. The circuit was closed, and the voltameter inserted (with copper electrodes in sulphate of copper). The unamalgamated zinc plate weighed, before the experiment, 21·893 gr.; and after the experiment, which lasted twenty minutes, 20·927 gr., having thus lost 0·966 gr. In the copper voltameter 0·244 gr. copper was separated out. The quantity of zinc equivalent to this, whose separation was attributable to the current, was 0·250 gr. In the closed circuit there was thus dissolved by the purely chemical process, which also occurred in the open circuit 0·966 gr.—0·250 gr.=0·716 gr. This quantity of zinc is almost the same as the first zinc plate lost in the open circuit.

With the same kind of zinc and sulphuric acid of the same specific gravity, several experiments were made, the results fully agreeing with those described. This appears to me important in reference to the contest between the chemical and the contact theories (though I cannot here pursue the subject further).

If, now, we were to ascribe the current-work ot liquid batteries to the caloric values of the diffusion processes, it must only be those which appear in the closed circuit; and evidence must be furnished that the diffusion takes place differently in the closed circuit from that in the open. Hitherto, such proof is wanting. But according to the experiments with the battery, sulphate of zinc, muriatic acid, acetate of protoxide of zinc, sulphate of zinc, the current here can neither be attributed to the one nor to the other, inasmuch as cold is produced by the diffusion.

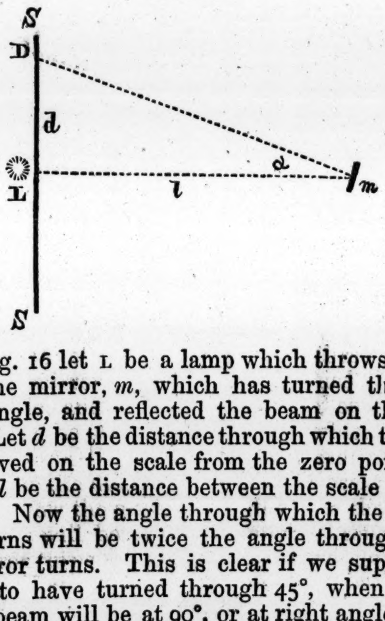
I incline, therefore, at least in the case of liquid batteries, to Nobili's opinion, that the currents produced by them have similar origin to that of thermal currents, and that the compensation for the current-work is to be sought in the heat absorbed from without. I am at present occupied in experimentally testing this view."

Students' Column.

Resistances and their Measurement. By H. R. Kempe.

The Thomson Galvanometer.—The accuracy with which measurements can be made depends chiefly upon the sensitiveness of the galvanometer em-employed in making those measurements. The Thomson reflecting galvanometer supplies this requisite sensitiveness, and is the instrument which is almost invariably employed when great accuracy is required, and also when very high resistances have to be measured. Its principle is that of employing a very light and small magnetic needle, delicately suspended within a large coil of wire, and of magnifying its movements by means of a long index hand of light. This index hand is obtained by throwing a beam of light on a small mirror fixed to the suspended magnetic needle, the ray being reflected back on to a graduated scale. This scale being placed about 3 feet distant from the mirror, it is obvious that a very small angular movement of the mirror will cause the spot of light reflected on the scale to move a considerable distance across it. The needle of the instrument being very small, and being placed in the centre of a large coil, the tangents of its deflections are directly proportional to the strength of the currents producing them.

Fig. 16.



In Fig. 16 let L be a lamp which throws a beam upon the mirror, m, which has turned through a small angle, and reflected the beam on the scale at D. Let d be the distance through which the beam has moved on the scale from the zero point at L, and let l be the distance between the scale and the mirror. Now the angle through which the beam of light turns will be twice the angle through which the mirror turns. This is clear if we suppose the mirror to have turned through 45°, when the reflected beam will be at 90°, or at right angles to the incident beam. If, then, we call a the angle through which the beam of light turns, $\frac{a}{2}$ will be the angle through which the mirror will have turned. Let $\frac{a_1}{2}$ and $\frac{a_2}{2}$ be the two angles through which the mirror has been turned by two currents, of strengths s_1 and s_2 respectively, then—

$$s_1 : s_2 :: \tan\frac{a_1}{2} : \tan\frac{a_2}{2};$$

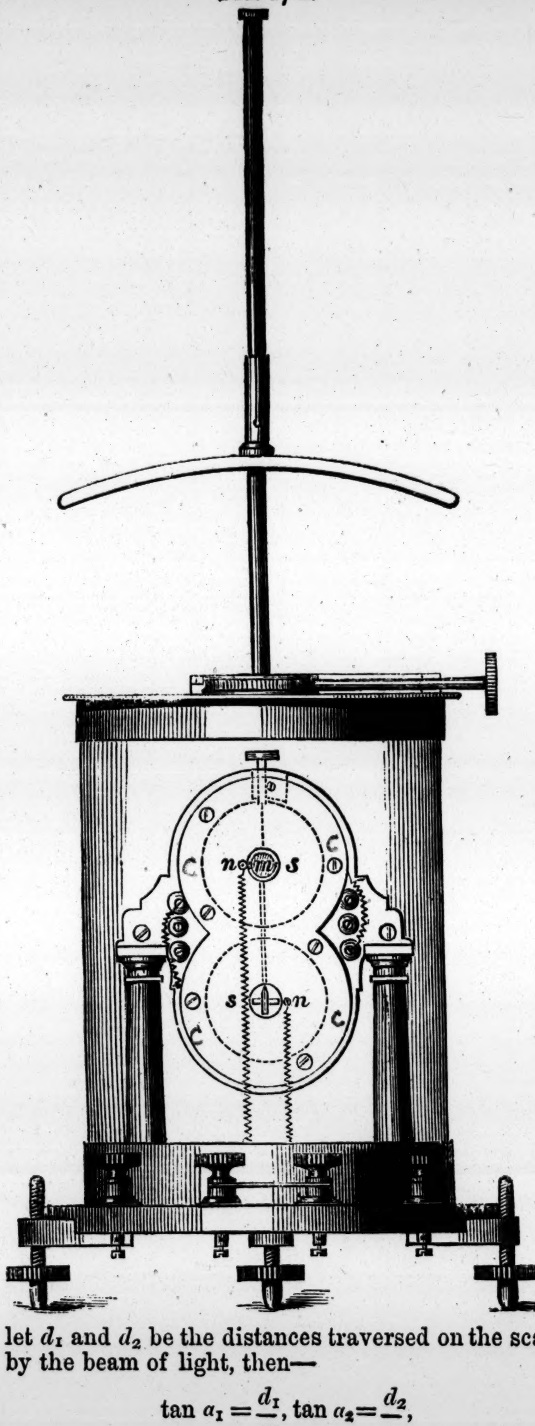
therefore—

$$s_1 : s_2 :: \frac{\sqrt{1+\tan^2 a_1}-1}{\tan a_1} : \frac{\sqrt{1+\tan^2 a_2}-1}{\tan a_2}$$

$\sqrt{1 + \tan^2}$ being positive, as the angles are less than 90°.

z being the distance of the scale from the mirror,

Fig. 17 A.



let d_1 and d_2 be the distances traversed on the scale by the beam of light, then—

$$\tan a_1 = \frac{d_1}{z}, \tan a_2 = \frac{d_2}{z},$$

therefore—

$$s_1 : s_2 :: \frac{\sqrt{1 + \frac{d_1^2}{z^2}} - 1}{\frac{d_1}{z}} : \frac{\sqrt{1 + \frac{d_2^2}{z^2}} - 1}{\frac{d_2}{z}},$$

therefore—

$$s_1 : s_2 :: d_2 (\sqrt{z^2 + d_1^2} - z) : d_1 (\sqrt{z^2 + d_2^2} - z);$$

when d_1 and d_2 do not differ largely, then we may take—

$$s_1 : s_2 :: d_1 : d_2,$$

but when this is not so the error may be considerable. For instance, suppose $z = 400$, $d_1 = 150$, and $d_2 = 300$. According to the above formula this would show that one current is just twice as strong as the other, but according to the correct formula we find—

$$s_1 : s_2 :: 300 (\sqrt{400^2 + 150^2} - 400) : 150 (\sqrt{400^2 + 300^2} - 400),$$

that is—

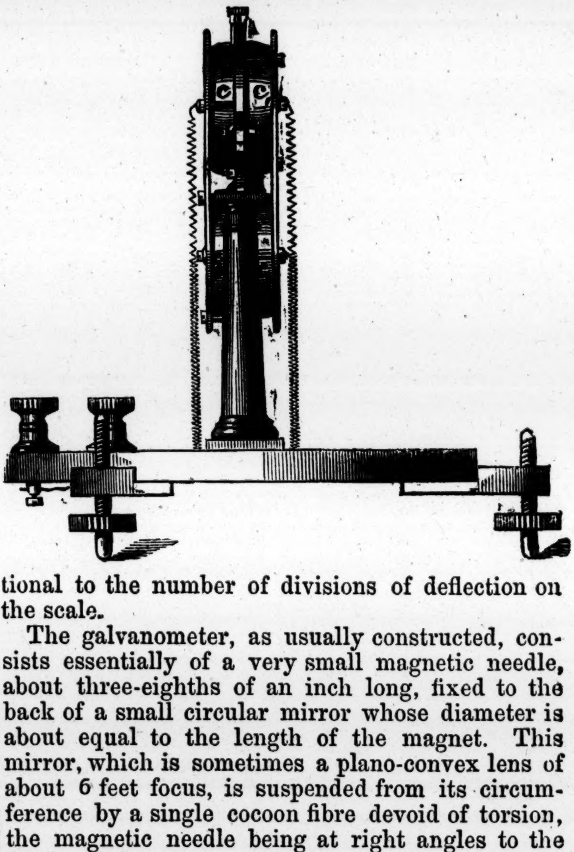
$$s_1 : s_2 :: 8100 : 15000,$$

or—

$$s_1 : s_2 :: 150 : 278,$$

so that when extreme accuracy is required we cannot take the strengths of currents as being proportional to the number of divisions of deflection on the scale.

Fig. 17 B.



The galvanometer, as usually constructed, consists essentially of a very small magnetic needle, about three-eighths of an inch long, fixed to the back of a small circular mirror whose diameter is about equal to the length of the magnet. This mirror, which is sometimes a plano-convex lens of about 6 feet focus, is suspended from its circumference by a single cocoon fibre devoid of torsion, the magnetic needle being at right angles to the fibre. The mirror is placed in the axis of a large coil of wire, which completely surrounds it, so that the needle is always under the influence of the coil at whatever angle it is deflected to. A beam of light from a lamp placed behind a screen, about 3 feet distant from the coil, falls on the mirror, the bottom of which is slightly in advance of the top, and is reflected back on to a graduated scale placed just above the point where the beam emerges from the lamp. The screen is, as we have before said, straight, and is graduated usually to 360 divisions on either side of the zero point.

The Thomson galvanometer is made in such a variety of forms that it will be impossible to describe them all; we purpose therefore only to describe one very common form in use.

Fig. 17 A is a front view, and Fig. 17 B is a side

view (with glass shade, &c., removed), of this form, one-third full size. It consists of a base formed of a round plate of ebonite, provided with three levelling screws; two spirit levels, at right angles to one another, are fixed on the top of this plate, so that the whole instrument can be accurately levelled. Sometimes one circular level only is provided, but the double level is much the best arrangement. From the base rise two brass columns, and between them a brass plate is fixed, rounded off at the top and bottom. Against the faces of this plate are fixed the coils (*c*, *c*, *c*, *c*) of the instrument. The brass plate has shallow countersinks in its surface for the faces of the coils to fit into, so that they can be fitted in their correct places without trouble or danger of shifting. Round brass plates press against the outer surfaces of the coils by means of screws, and keep them firmly in their places. There are two round holes in the brass plate coinciding with the centre holes in the coils. The coils themselves, which are four in number, as will be seen in the figure, are wound on bobbins of thin material, the wire being heaped up towards the check of the bobbin which bears against the brass plate. This heaping up is done in accordance with the law of Sir William Thomson, so as to obtain, as far as possible, a maximum effect out of a minimum quantity of wire. The edges of the coils are covered with shellac, so as to protect the wire from mechanical injury. Within the holes in the brass plate are placed two little magnets, *n s* and *s n*, formed of watch-spring highly magnetised; they are connected together by a piece of aluminium wire, so as to form an astatic pair of needles. A small groove is cut in the brass plate, between the upper and lower hole, for the connecting aluminium wire to hang freely in. In front of the top needle is fixed the mirror. The suspension fibre is attached, at its upper end, to a small stud, which can be raised or lowered as required. When pressed down as far as it will go the needles rest on the coils, and the tension is taken off the fibre, so that the instrument can then be moved about without danger of breaking the fibre. One end of each coil is connected to one of the four binding screws in front of the base of the instrument, the other ends being connected to one another through the medium of the little binding screws placed midway on either side of the coils. The connections are so made that when the two middle binding screws on the base of the instrument are joined together, the whole four coils are in the circuit of the two outer binding screws, so that they all four act on the magnetic needles. Some better arrangement for connecting the four coils together than that at present adopted is highly desirable, so that they can be coupled up in series, by which means the resistance of the galvanometer could be reduced to one-fourth the resistance of one of the coils, that is, one-sixteenth of that of all the coils together. By connecting the first binding screw on the base with the third, and the second with the fourth, the coils will be coupled up so as to reduce the resistance of the coils to one-fourth of the total resistance of all the coils together. Over the coils a glass shade is placed from the middle of the top of which a brass rod rises. A short piece of brass tube slides over this rod with a weak steel magnet slightly curved fixed at right angles to it. This magnet can be thus slid up or down the rod, or twisted round as occasion may require. For fine adjustments a tangent screw is provided, which turns the brass rod round and with it the magnet.

We have said that the mirror is sometimes made of a plano-convex lens. This is done so as to obtain a sharp image of the spot of light on the scale. The width of this spot of light can be regulated by means of a little brass slider fixed over the hole in the screen through which the beam emerges from the lamp. A much better arrangement than the spot of light is made with some instruments. The hole through which the light emerges is made round, about the size of a sixpence, with a piece of fine platinum wire stretched vertically across its diameter. A lens is placed a little distance in front of this hole, between the scale and galvanometer, so that a round spot of light with a thin black line across it is reflected on the scale. This enables readings to be made with great ease, as the figures on the scale can be very distinctly seen. The mirror in this arrangement may be a plane one. When the spot of light only is used, it is necessary to partially illuminate the scale with a second lamp.

To set up the Galvanometer.—It is essential before proceeding to set up the instrument for use to see that that the ebonite base is thoroughly dry and clean, so that there may be no leakage from the wires to interfere with the tests taken. Indeed, it is as well to place the galvanometer and the other apparatus to be used on a large sheet of gutta-percha or ebonite, more especially if the room in which the tests are to be made is at all damp. Sometimes little ebonite cups are provided for the levelling screws of the instrument to stand in, which answers the purpose of insulating very thoroughly.

The instrument should be set up on a very firm table in a basement story. It is almost useless to test with it in an upper room, as the least vibration sends the spot of light dancing and vibrating to and fro. At all cable works the instrument is placed on a solid brick table built on the earth, so that no vibration can possibly affect it.

A suitable table being chosen, place the galvanometer so that the two front levelling screws stand north and south, the front facing west. This is best done by drawing a line on the table exactly north and south, and placing the levelling screws on it. The levelling screws are then adjusted until the bubbles of the level or levels show the instrument to be perfectly level. Now remove the glass shade and gently raise the stud at the top of the coils. This should be done by squeezing the tips of the fingers between the bottom of the head of the stud and the top of the brass plate in which it runs. If the stud is raised by a direct pull there is almost a certainty of its coming up with a jerk and breaking the fibre. On no account must the stud be twisted round, except to get rid of any torsion which may exist in the fibre when it has to be replaced after becoming broken. The stud being raised sufficiently high to allow the mirror to swing clear of the coils, the glass shade may be replaced and the brass rod with the magnet on it screwed on to its top, and the magnet placed about half way up the rod, the poles being placed so as to assist in keeping the magnetic needles north and south. The scale lamp being lighted, place it in its proper position on the scale stand, the *edge* of the wick being turned towards the brass slider regulating the width of the beam of light. The slider being opened to its full extent, the scale and lamp should be placed about 3 feet from the galvanometer, so that it stands parallel with the faces of the coils, and also so that a line drawn at right angles to the scale from the lamp hole will pass through the centre of the galvanometer. The reflected beam of light should then fall fairly on the scale. If too high this may be remedied by propping up the scale, and if too low, by screwing up the levelling screws of the galvanometer.

It is easier to prop up the scale than to lower the galvanometer by means of the levelling screws, if the light is too high on the scale.

The spot of light being obtained at the zero point on the scale by turning the regulating magnet of the galvanometer by means of the screw, the spot of light should be focussed by advancing or retreating the lamp and scale until a sharply defined image is obtained on the scale; the width of the slit may then be diminished by means of the brass slide until a thin line of light only is obtained on the scale. If the round spot of light with the line across it is used, the focussing must be made so that the black line of light is sharply defined.

The position of the scale and galvanometer being once defined, their positions on the table may be marked for future occasions or at least the exact distance of the scale from the galvanometer noted, so that it can be placed right when required without trouble. The instrument is now ready for use. If not required to be sensitive, place the regulating magnet low down; if, on the contrary, it is required to be sensitive, place it high up. To obtain its maximum sensitiveness the following device must be adopted:—Raise the magnet to the top of the bar, and when there turn it half round so that its poles change places. The magnet will now be opposing the earth's magnetism, and consequently will tend to turn the magnetic needles round. If the magnet is at the top of the rod, the effect of magnetism of the earth on the magnetic needles will be more powerful than the magnetism of the regulating magnet, and the needles will tend to keep north and south; but by lowering the regulating magnet a point is reached where its magnetism just counteracts the earth's magnetism. Under these conditions the needles will stand indifferently in any position. By placing the regulating magnet about an inch higher than the position which gives this exact counteraction, the magnetism of the earth will be just sufficient to keep the magnets north and south, and consequently the spot of light at the zero on the scale, and at the same time, leaves them free to be moved by a very slight force. It will be noticed with the regulating magnet in this position, that in order to get the spot of light at the zero point, the magnet must be turned in the opposite direction to that in which it is required that the needles should move.

It is not advisable to adjust the instrument too sensitively because it is difficult then to keep the spot exactly at zero, as any slight external action may throw it a degree or two out.

(To be continued).

THE BRAZIL CABLE.—RIO DE JANEIRO, JUNE 26.—Congratulatory telegrams have been exchanged between their Majesties Queen Victoria and the Emperor of Brazil on the occasion of the completion of the telegraph cable between Europe and Brazil.

Electrical Science in English and Foreign Journals.

(In addition to our usual abstracts, there will be found under this heading the titles of papers on electrical science which have appeared in English and foreign journals from the commencement of the present century up to the date of the establishment of this journal).

VOL. XXV. (1832).

Experimental Researches on Electricity. Mr. Faraday. Pp. 91 to 142.

Simple Production of the Magnetic Spark. M. Strehlke. P. 186.

On the Magnetic Inclination of St. Petersburg, and its Daily and Annual Variations. M. Kupffer. P. 193.

On the Magnetic Inclination and Declination at Peking. M. Kupffer. P. 220.

On Determination of the Absolute Magnetic Force. M. Moser. P. 228.

Researches on the Magnetic Declination of St. Petersburg, and its Monthly and Annual Variations. M. Kupffer. P. 455.

Contributions to Monography of Marehanite, Tourmaline, and Brazilian Topaz, with reference to Electricity. M. Erman. P. 607.

VOL. XXVI. (1832).

No papers in Electricity or Magnetism.

VOL. XXVII. (1833).

On the Relative Intensity of Terrestrial Magnetism in Paris, Brussels, Göttingen, Berlin, and Stockholm, in the Year 1832. M. Rudberg. P. 5.

New Construction of a Magneto-Electric Machine. M. Pixii. P. 390.

On Chemical Action, especially Decomposition of Water through Electro-Dynamic Induction. M. Hachette. P. 394.

On an Experiment of M. Pixii, with Apparatus of his Invention Concerning Production of Electric Currents through Rotation of a Magnet. M. Ampere. P. 398.

Physical Theory of Electro-Dynamic Induction. M. Nobili. P. 401.

New Electro-Dynamic Condenser. M. Nobili. P. 436.

Researches on Several Heat Phenomena, with a Thermo-Multiplier. MM. Nobili and Melloni. P. 439.

On the Sensitiveness of the Thermo-Multiplier in Comparison with the Æthrioscope. M. Nobili. P. 455.

On a Species of Chemical Action Produced at the Surface of Metals by Magneto-Electric Currents. M. Marianini. P. 459.

Extract from Treatise on Production of Electro-Magnetism through Simple Induction of the Polarisation in an Unmoved Magnet. M. Erman. P. 471.

On the Chemical Action of Atmospheric Electricity. Mr. Barry. P. 478.

Researches on the Electricity of Torpedoes. Mr. John Davy. P. 542.

Electro-Magnetic Rotation of Water. Mr. Ritchie. P. 552.

VOL. XXVIII. (1833).

On a Method of Ascertaining the Position and Force of a Variable Magnetic Pole. M. Moser. Pp. 49, 273.

On the Chemical Action of Thermo-Electric Currents. M. Botto. P. 238.

The Intensity of Terrestrial Magnetic Force Reduced to Absolute Measure. M. Gauss. Pp. 241, 591.

On the System of Magnetic Intensity of the Earth. M. Hansteen. Pp. 473, 578.

Experiments on Attractions and Repulsions of the Galvanic Circuit-wire and the Magnetic Needle. M. Dove. P. 586.

Vol. XXIX. (1833).

Third Series of Experimental Researches on Electricity. Mr. Faraday. Pp. 274, 365.

Magneto-Electric Electro-Magnets. M. Dove. P. 461.

On the Power of an Electro-Magnet to Retain its Magnetism after Opening of the Voltaic Battery. Mr. Ritchie. P. 464.

On Certain Peculiar Properties of Ordinary and of Electro-Magnets. Mr. Ritchie. P. 467.

On the Formation of Artificial Magnets through Galvanism. M. Moll. P. 468.

Vol. XXX. (1833).

No papers on electricity or magnetism.

Vol. XXXI. (1834).

On the Daily Variations of the Magnetic Declination in Freiberg. M. Dove. P. 97.

Electro-Magnetism of Metallic Veins. P. 112.

On the Magnetic Inclination at Freiberg. M. Reich. P. 199.

Reduction of Mr. Faraday's Magneto-Electric Induction to a Common Law. Mr. Ritchie. P. 203.

On the Continuous Rotation of a Closed Voltaic Circuit. Mr. Ritchie. P. 206.

A hitherto-unobserved Property of Electro-Magnets. P. 208.

Fourth Series of Mr. Faraday's Experimental Researches on Electricity. P. 225.

Experiments to ascertain the Commencing Action of the Metallic Plates in the Voltaic Battery. M. Dal Negro. P. 261.

Notice on Electro-Magnets. M. Jacobi. P. 367.

On Conduction of Electricity in Moist Air. M. Munck af Rosenschöld. P. 433.

On Determination of the Direction of Currents produced through Electro-dynamic Division. M. Lenz. P. 483.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxviii., No. 20. May 18, 1874.

On Magnetic Bundles Formed by Plates Separated by Intervals.—By M. J. Jamin.—Coulomb, in his study respecting magnetised bundles, contented himself with measuring their magnetic moment. He found that this moment increases less rapidly than the number of plates. The problem was badly put, for it was to measure the force of a bundle by the product of two factors—the totality of the magnetism and the distance of the pole from the centre. Now these two factors vary at once and in opposite direction. It was far simpler to seek the law which governs one only of these two factors, and it was that which led M. Jamin to estimate the total magnetism, and to prove that in a bundle it is rigorously equal to the sum of the magnetism of the elements. He now demonstrates how the laws of bundles modify themselves without ceasing to be very simple, when the plates, instead of being rigorously attached and close to one another, are purposely separated by regular intervals.

Electric Chronographs.—By Marcel Deprez.—In every chronograph there are three distinct kinds of organisms: —(1) to print the movement of the projectile on paper; (2) registers to leave a trace on the paper at the moment when the body passes certain determined marking points; (3) a registering apparatus of equal intervals of time. Called upon to make a deep study of these machines in order to render them reliable registers, he used one of Schultz's chronographs, one of the features of which is rapid vibrations of a tuning-fork. The registering of the successive moments of the phenomenon to be studied was made by means of the induction spark. M. Marcel Deprez first determined the delay of the spark, *i.e.*, the time interval which passes between breakage of the inducting current and the spark's explosion, by causing the chronograph's own cylinder, which carried an insulated sector, to break the circuit. He commenced by turning the cylinder very slowly, when a certain mark was obtained at the moment in which the insulating sector broke the inducing current; then, spinning it round with great swiftness, a new mark was obtained, produced by the spark which struck the cylinder during this rapid movement. All the results of his experiments cannot be given; suffice it to say they showed that of all registering processes the induction spark is by far the most rapid, the *delay* being generally below $\frac{1}{10000}$th of a second. Certain serious inconveniences render its employment almost inadmissible. Indeed its production is very capricious, and much depends on the manner in which the inducing current is broken. It almost always strikes the cylinder at a great number of points, when it leaves a mark like a comet with a tail composed of sparks. When the speed of the cylinder is very great the mark becomes extremely uncertain. Notwithstanding all these inconveniences, it is perhaps preferable to other methods of registering by reason of its instantaneousness, provided, with a single coil, an extremely large number of sparks can be produced in a second. Unfortunately we cannot do so. The number of sparks produceable in a second do not exceed two or three hundred, and then only with a strong battery and a very small explosive distance. As to the use of electro-chemical paper very little is to be said: it has been abandoned because the mark presents a very uncertain ending. Lastly, electro-magnets appeared utterly inadmissible under the circumstances in which he was placed.

No. 21. May 25, 1874.

Memoir of a New Application of Subterranean Hydraulic Motors and Gramme's Magneto-Electric Machine to the Lighting of Main Roads.

No. 22. June 1, 1874.

The Part which the Middle Section, the Polar Surfaces, and the Armatures, Play in a Magnet.—By M. J. Jamin.—This paper confirms, by further experiments (details of which cannot be inserted here) his former ideas with regard to magnets, which have already appeared in our columns.

Note on Magnetism.—(Continuation from page 173), by M. J. M. Gaugain, paragraphs 64—69.—Former experiments and discussions related to the magnetisation of soft iron. The researches now refer to the magnetisation of saturated steel. Most of his remarks in these paragraphs relate to preparations for his experiments.

Improvement in Electrical Chronographs, and Researches on Electro-Magnets.—By Marcel Deprez.—In a previous communication (see No. 20) he recognised that the induction spark has inconveniences which weaken the really important single advantage of instantaneousness which it possesses; therefore, his enquiries were directed to the use of electro-magnets. He succeeded in devising a chronograph with the use of electro-magnets, and in order to overcome the objection of magnetic retention of the armature producing loss of speed in registering, he devised the following apparatus:—A pen fixed to a little axis, movable on two pivots, to which is soldered a lever arm whose extremity carries a small sheet of tinsel or vegetable paper. The weight of the sheet, if of paper, does not exceed ten milligrammes, and can resist a strain of 1 kilogrm. without tearing. The pen is pinched between the armature and the magnetic pole. An india-rubber thread exercises over it, by means of the lever, an effort of 400 to 500 grms. If, now, the magnetic attraction is destroyed, the friction upon the pen is suppressed, and the traction effort of the india-rubber thread bears away the pen with its sheet of tinsel or paper, although the armature of the electro-magnet receives no movement. Its inertia thus plays no part, and its mass may therefore be selected so as to obtain the greatest possible magnetic force. The author will, at a future date, explain other methods he has invented.

Scientific American. Vol. xxx. No. 20 and 21. May 16 and 23, 1874.

Contains nothing relating to electrical matters.

No. 22. May 30, 1874.

A New District Telegraph Instrument has been designed by Mr. H. E. Towle, and Mr. W. Unger, of New York, to replace the apparatus now employed on the district telegraph lines. The device, like the ordinary instruments, gives three distinct calls, "police," "messenger," and "burglar alarm," and may be used for transmitting signals by sound. The notched wheels which break and close the circuit at certain times, making a distinctive signal in the ordinary apparatus, are replaced by vertical bars formed of metal and rubber, so arranged that the switch passing over them receives the current when touching the metal portions, which are placed at certain intervals apart, and transmits the same to the sounding device at the main office. The machine is set in motion by pressing a button, which removes a detent from holding the clockwork. A rod then rises from the top of the apparatus until the signal is completed, when it is pushed down, thus winding up the mechanism ready for another signal. The burglar alarm is so arranged that, by breaking a wire or connection, the current, which before preferably traversed that wire, passes to an electro-magnet, setting the device in action and transmitting a proper signal.

No. 23. June 6, 1874.

Electro-Plating with Cobalt.—The following process of George W. Beardslee, of Brooklyn, N.Y., is stated to form a thick and useful covering, which will perfectly protect the plated surface, and forms a plating, very white, hard, and durable. Dissolve the pure metal cobalt in boiling hydrochloric acid, and evaporate this solution to dryness. Then dissolve from four to six ounces of the salt thus obtained in a gallon of distilled water, to which add ammonia sufficient to show on test-paper the solution just slightly alkaline. Then prepare an anode of the metal cobalt, in granular form or broken into small pieces, free from impurities, as follows:—Take a plate of carbon (or some other material that is a conductor of electricity, but not susceptible of being attacked by the plating solution), and place it within an envelope of some material that is neither a conductor of electricity nor attackable by the solution, formed with open meshes or interstices through which the solution may freely circulate. This envelope should be made to conform in shape to the carbon plate, and large enough to leave a space between it and the plate of, say, one-half an inch to one inch; then fill this space with the granules of cobalt, which will, as is evident, surround the plate and be in contact with it. By an anode thus constructed, a large surface of the cobalt is readily and conveniently exposed to the action of the solvent, and the steady flow of the entire battery current through the cobalt is secured, thereby rendering the dissolution and deposition of the metal steady, uniform, and very perfect. This anode is to be connected with the copper pole of the battery by connecting the wire to the carbon plate and suspending it in the plating solution before described. The article to be plated is connected in the solution with the zinc pole in the usual way. A battery power of from two to five cells (Smee's battery) will be sufficient to do good work. Care should be taken not to permit the solution to lose its slightly alkaline character, as if this is not maintained, the plating operation will be rendered imperfect, the tenacity, adherence, and uniformity of the deposit becoming thereby impaired.

Le Mondes. Vol. xxxiv., No. 5. June 4, 1874.

This number contains nothing of interest.

The Journal of the Franklin Institute. Vol. xcvii. No. 580. May, 1874.

Has nothing in it relating to electricity.

Patents.

Applications for Letters Patent.

1684. W. A. Camp, of New York, now of 8, Southampton-buildings, London, for an invention of "Improvements in telegraphic signalling apparatus."—*Dated* 12th *May*, 1874.

1712. J. McCool, engineer, of Plumstead, Kent, for an invention of "Improvements in sockets to receive the ends of telegraph and other posts or uprights, and in apparatus to be employed in lowering the posts or uprights into and withdrawing them from their sockets."—*Dated May* 14, 1874.

1766. M. Eustace, of Elmhurst, Glasnevin, Dublin, for an invention of "Improvements in means and apparatus for jointing and tightening wires, such as are employed for fences, telegraphs, and other purposes."—*Dated May* 19, 1874.

1779. L. Finger, of Boston, U.S., for an invention of "Improvements in electro-magnetic annunciators." (Complete Specification).—*Dated May* 19, 1874.

1820. E. O. W. Whitehouse, of 12, Thurlow-road, Hampstead, Middlesex, for an invention of "Improvements in producing electric light."—*Dated May* 22, 1874.

1932. W. R. Lake, of London, for an invention of "Improvements in electric telegraphs."—A communication to him from abroad by L. Vianisi, of Messina. *Dated June* 3, 1874.

1954. W. P. Lyon, of London, for an invention of "Improvements in the means or method of applying magnetism for curative and other purposes." *Dated June* 5, 1874.

1966. J. W. Brown, of London, electrical engineer, for an invention of "Improvements in the mode of and apparatus for transmitting telegraphic signals." *Dated June* 5, 1874.

Notices to Proceed.

256. J. B. Stearns, of Boston, U.S., now of Southampton Buildings, London, electrician, has given notice in respect of the invention of "Improvements in electric telegraph apparatus."—Partly the result of a communication to him from abroad by J. C. Upham, of Sydney, Cape Breton, Nova Scotia, and partly of invention and discovery made by him.

917. E. G. Bartholomew, of Hampstead Road, Middlesex, telegraphic engineer, and J. Neale, of Stoke-on-Trent, telegraph engineer, have given notice in respect of the invention of "Improvements in signalling by electricity, and in appliances therefor."

Abridgments of Provisional and Complete Specifications.

3375. J. H. Johnson, of Middlesex. (A communication from L. H. M. Galliand and E. Breittmayer, both of Paris). *An improved code suitable for electro-telegraphic dispatches.* Dated October 18, 1873.—This invention relates to an improved code to be employed in the transmission of electro-telegraphic dispatches. According to this invention it is proposed to adopt letters only, as their combinations furnish a greater number of abbreviative words than figures do, and a secret language has been formed, all the words of which are represented by a number of letters less than five and the least number possible.

3436. S. C. Dunk, of Surrey. *Improved means of preserving telegraph signal gate and other wood posts from dry-rot and decay.* Dated October 22, 1873.—This invention has for its object improved means of preserving telegraph, signal, gate, and other wood posts, the lower ends of which are inserted in the ground, from dry rot or decay. According to this invention the lower parts of such wood posts are surrounded with a collar or coating of zinc or other suitable metal, the upper and lower edges of such collar being bevelled off and either forced into the wood, or caused to enter a saw cut or channel formed at an angle in the surface of the post around which it is placed. When the plate or collar of zinc is fixed around the post, the edges are soldered together to form a perfectly water-tight joint.

3437. E. T. Hughes, of the firm of Hughes and Son, London. A communication from J. B. Blythe, of Bordeaux, France. *Treating wood and vegetable fibre in general by "carburetted steam" and compression, to strengthen and preserve such matters from decay.* Dated October 22, 1873.—I construct an apparatus consisting of a strong iron chamber forming an oven, and a long boiler extending the whole length of the oven is set in the brickwork below it. Flues are arranged around the oven to heat it externally, and are connected with a furnace or furnaces. Pipes with stop-cocks connect the top of the boiler with the upper part of the oven, and a return pipe also provided with a stop-cock connects the bottom part of the oven with the bottom part of the boiler. Safety valves are also provided. The wood is placed in the oven and the boiler is charged with water, to which is added from one-third to one-fifth by weight of heavy hydrocarbon oil. The water and oil is heated together, making "carburetted steam," which passes into the oven by the upper pipes, while the liquids condensed in the oven return to the boiler by the lower pipes which connect them together. After the temperature in the oven has attained 212° F., the heating is continued till all the albumen and sap in the wood is decomposed into resin, acetic acid, and oleaginous matter, which are distilled for after treatment.

3461. W. E. Newton, of Middlesex, civil engineer. (A communication from J. S. Camacho, of the city of Havana, in the Island of Cuba. *Improvements in the construction of electro-magnets.*— Dated October 24, 1873.—The invention consists of an electro-magnet composed of a series of concentric cylinders, all being of equal length, and each one containing one or more coils of continuous wire, whereby the strength of the magnet is increased in proportion to the number of tubes.

3519. I. L. Pulvermacher, of Middlesex, electrical engineer. *Improvements in apparatus or appliances connected with generating, conducting, and applying electricity for medical and other purposes.*—Dated Oct. 29, 1873.—This relates to details upon apparatus or appliances connected with generating, conducting, and applying electricity, the details being based upon previous inventions patented by Mr. Pulvermacher.

3540. C. A. Faure, of Middlesex. *Improvements in the construction of thermo-electric batteries or piles, and in the application of the electric currents derived therefrom through the medium of a novel arrangement of electro-magnets.* Oct. 30, 1873.—The novelty of the invention consists in arranging two plates or cylinders in such a manner that there will be an opening or annular space formed between them, which is filled with sulphuret of lead or "galena;" one of the plates or cylinders is kept hot by artificial means, and the other cool by the application of water. The two plates or cylinders form the poles of the thermo-pile, which are connected together by a suitable conductor, and which receives the electro current passing through the "galena," and transmits it to a magnet around the cores of which a number of separate isolated strands of wire are wound, each strand being separately connected with the poles of the battery or thermo-pile, thereby producing electro-magnetic power, which actuating an armature through a series of "break" and "make" currents, a revolving motion to a shaft is given which may be employed for driving purposes.

3619. J. J. F. Stevens, railway signal manufacturer. *An improved contact apparatus for electric indicators for railway signals.* Dated November 6, 1873.—This provisional specification describes a quadrant mounted loosely on an axis, and held in place by a metal spring which is fixed thereto, and bears against one of two insulated metal pieces, which are in connection in the usual manner with the electric indicator. The quadrant is moved by an arm worked from the rod which removes the signal; when the quadrant is moved so that the spring bears against both the metal pieces, contact is made, and when it is moved so that the spring bears against only one of the metal pieces, contact is broken.

UNITED STATES.

146,758. L. Finger, Melrose, Mass. *Electric-Annunciator.* Dated February 1, 1873.—A cylinder upon which various wants are indicated, is revolved by clockwork, controlled by an electro-magnet, till proper order is displayed at an opening in outer case. Caller has a series of inclined pivoted levers caused to close a circuit by tilting. A ball, introduced into an aperture opposite the article called for, runs over a series of the levers, closing circuit proper number of times to cause the cylinder to be revolved and show name of article desired.

146,996. B. Eby, of Salisbury township, near Kinzer's Post-office, Lancaster county, Pa. *Telegraph insulator.* Dated August 5, 1873.—A sectional insulating plug, through which the wire passes, is secured by a groove which fits over a flange in a cylindrical vertical holder formed to shed rain from the wire, which is fastened from slipping by a leaden or other non-conducting wire.

147,020. J. P. Putman, Boston, Mass. *Apparatus for lighting gas by frictional electricity.* Dated July 5, 1873.—The turning of the gas cock rotates the electrophorus, brings the burner in proper relation to the conducting wires for being lighted, and immediately afterwards separates the wires from the flame.

147,183. J. E. Smith, New York. *Printing telegraph.* Dated May 15, 1873.—Two line wires, type wheel magnet in one circuit, printing, unison, and an additional coil, reverse to main coil, on type wheel magnet in other circuit, which is normally closed. While a resistance is in circuit the current cannot energise printing magnet, the printing being affected by cutting resistance.

147,186. J. E. Smith, New York. *Morse telegraph register.* Dated May 2, 1873.—Pad or spring on armature lever stops clockwork by friction while circuit is closed, Speed governed by a pallet instead of fly.

147,311. T. A. Edison, Newark, N.J., and G. Harrington, Washington, D.C. *Electric Telegraph.* Dated July 29, 1873.—States that the static charge of a line proceeds in both directions from the centre of resistance of the line, and that at such centre the tension of the static or extra charge is zero, and that if the receiving instrument be placed at that point there will be no tailings. Makes such point by putting in a resistance between instrument and earth equal to resistance of line and instrument.

147,312. T. A. Edison, Newark, N.J., and G. Harrington, Washington, D.C. *Perforator for automatic telegraphy.* Dated July 29, 1873.—General features as in Edison's patent of December 5, 1871, improvements being in feeding devices.

147,313. T. A. Edison, Newark, N.J., and G. Harrington, Washington, D.C. *Chemical telegraph.*—Dated July 29, 1873.—Instead of single electro-magnet in a shunt circuit to the receiving and transmitting instruments, as in his patent No. 135,531, a number are employed, with a switch for throwing more or less into circuit, as in the case of the ordinary rheostat. Uses ordinary rheostat in connection with the series of magnets.

147,314. T. A. Edison, Newark, N.J., and G. Harrington, Washington, D.C. *Circuit for chemical telegraphs.* Dated July 29, 1873.—Opposing batteries at each end of line, transmitter and receiver being placed in short circuits to their respective batteries. The short circuit of transmitting battery being broken, its current is forced over line, neutralising effect of receiving battery. Roller wheel falling in a perforation makes the short circuit, allowing receiving battery to act.

147,352. H. Van Hoevenbergh, Brooklyn, N.Y. *Telegraph Apparatus.* Dated August 16, 1873.—Call bell driven by clockwork released by an electro-magnet. Current derived from a magneto-electric machine in which the permanent magnet is fulcrumed and forms the operating key.

147,487. G. D'Infreville, New York, and W. N. Armstrong. *Duplex telegraph.* Dated April 25, 1873.—No additional local or split batteries used. Two main batteries opposed, and battery at sending station localised, for preserving equilibrium. 1. The method of duplex telegraphing, substantially as described, by localising or short circuiting the main battery at the sending station, thereby preserving the magnetic equilibrium in the signalling instrument of that station, and allowing the battery of the receiving station to exert its full force in recording or indicating signals. 2. In combination with a normally closed telegraphic line having main batteries, one at each terminal, connected to the line in opposition to each other, open circuit single contact keys, and branch circuits connected to the relay magnets at a suitable point, the closing of the said keys short-circuiting or localising the battery of the sending station through the proper proportion of the coils of the relay. 3. In combination with a relay magnet having its layers exposed for connection to key, and for approximate adjustment, as described, the shunt circuit and rheostat. 4. In combination with the normally closed line, having branch circuits and open circuit single contact keys, and opposed batteries, as described, the battery reversers and closed circuit keys. 5. The combination, at an intermediate or way station, with the main line of a duplex telegraph, of the open circuit key and branch circuit connected to the relay between the terminals, the depressing of the key closing independent circuits for both terminal batteries, giving signals to both sides of the way station in single transmission, or forming a duplex line with one terminal.

147,524. J. B. Stearns, Boston, Mass. *Duplex telegraph.* Dated February 21, 1873.—Current divided at a point between the line and relay of sending station, the line current going to distant station and returning through home relay to battery, the equalising or local current going directly through home relay, the effects being neutralised therein, and, through an additional relay, enabling the sender to read his own writing.

147,525. J. B. Stearns, Boston, Mass. *Duplex telegraph.* Dated February 21, 1873.—Equalising current passed through coil around armature of relay, so as to neutralise inductive effect or relay magnet thereon.

5,768. G. L. Leclanche, Paris, France, assignor to Hilborne L. Roosevelt, New York City. Patent No. 64,113, dated April 23, 1867. (Reissue). *Galvanic battery, and combining therewith secondary or accumulating batteries.* Dated January 27, 1874.—Peroxide of manganese sealed up in porous cup with graphite, muriate of ammonia used in solution. Accumulating cells used in connection therewith. 1. The combination, with the other necessary elements of a galvanic battery, of peroxide of manganese. 2. The combination, in or with the porous cells of a galvanic battery, of an anode and salt or salts to be decomposed. 3. The combination, with the anode in a porous cell, of the decomposing and to be decomposed salts packed therein in a dry state. 4. The combination, with the anode in a porous cell, of salts highly insoluble, and salts for decomposing the same by electrolytical action. 5. The graphite plates, the flask, and the porous vase, all in combination. 6. A polarising apparatus in combination with the battery. 7. The combination, in general, in a galvanic battery, of the ammoniacal salts with the peroxide of manganese.

The Brazilian Submarine Telegraph Company, Limited, have notified that their cable between Lisbon and South America, *via* Madeira and St. Vincent, to Pernambuco, is now open, and that messages from London should be sent from the Eastern Company's Station, 74, Old Broad-street.

The Eastern Extension, Australia, and China Telegraph Company, Limited, have declared an interim dividend for the quarter ended March 31, at the rate of 6 per cent. per annum, or 3s. per share, payable on the 15th of July.

To Correspondents.

⁂ Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Telegraphic Journal" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher.

SUBSCRIPTIONS.

Copies of the journal may be obtained through newspaper agents in every part of the world. Should any difficulty arise in procuring copies, direct communication with the Publisher is requested.

Gentlemen desiring to subscribe and receive this paper regularly, are requested to send a remittance to the Office at Boy Court, Ludgate Hill, London, E.C., for 9s., if residing in the United Kingdom; if in Africa, Australia, Belgium, Brazil, Canada, Egypt, France, Gibraltar, Jamaica, Malta, Mexico, Monte Video, Natal, New Zealand, Sweden, United States, West Indies—10s.; if in Austria, Ceylon, China, Holland, India, Italy, Japan, Portugal, Germany, South America (West Coast), Spain, Switzerland, Turkey, Valparaiso—12s.; if in Russia, 14s.

Cheques and Post Office Orders to be made payable to Henry Gillman, and to be crossed "London and County Bank."

ALL SUBSCRIPTIONS PAYABLE IN ADVANCE.

J. P. W.—It is impossible to explain without details. Do the wires run parallelly, and at what distance apart? Is the battery put to earth, or are there return wires?